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(54) METHODS OF AUTHENTICATING USERS TO A SITE

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G06F 21/41	(2013.01)
H04L 9/32	(2006.01)
H04W 12/06	(2009.01)

(52) **U.S. Cl.**
CPC ***H04L 63/08*** (2013.01); ***G06F 21/41*** (2013.01); ***H04L 9/321*** (2013.01); ***H04L 63/0815*** (2013.01); ***H04L 63/10*** (2013.01); ***H04W 12/06*** (2013.01)

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CPC H04L 63/08; H04L 63/0815; H04L 63/10; H04L 9/321; G06F 21/41; H04W 12/06
See application file for complete search history.

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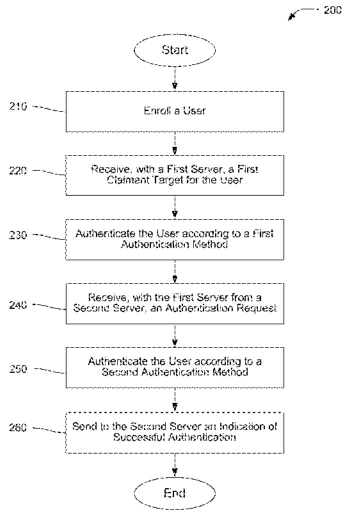
(57) ABSTRACT

Systems and methods for user authentication within federated computing systems are provided. In a session, a user can be authenticated multiple times by different authentication methods for different servers of the federated system, however, once the user has been authenticated by any given authentication method, the user need not repeat that method. Systems of the present invention comprise a plurality of servers including an authentication server. The authentication server maintains authentication records for users, where each record includes which authentication methods apply to which servers. When a user first seeks access to a particular server, the server identifies the user and the server to the authentication server. If the user has already been authenticated elsewhere according to the authentication method required by the new server, the authentication server indicates to the new server that the user is authenticated, else the authentication server invokes the necessary authentication method.

8 Claims, 2 Drawing Sheets


200
Start
210
Enroll a User
220
Receive, with a First Server, a First Claimant Target for the User
230
Authenticate the User according to a First Authentication Method
240
Receive, with the First Server from a Second Server, an Authentication Request
250
Authenticate the User according to a Second Authentication Method
260
Send to the Second Server an Indication of Successful Authentication
End

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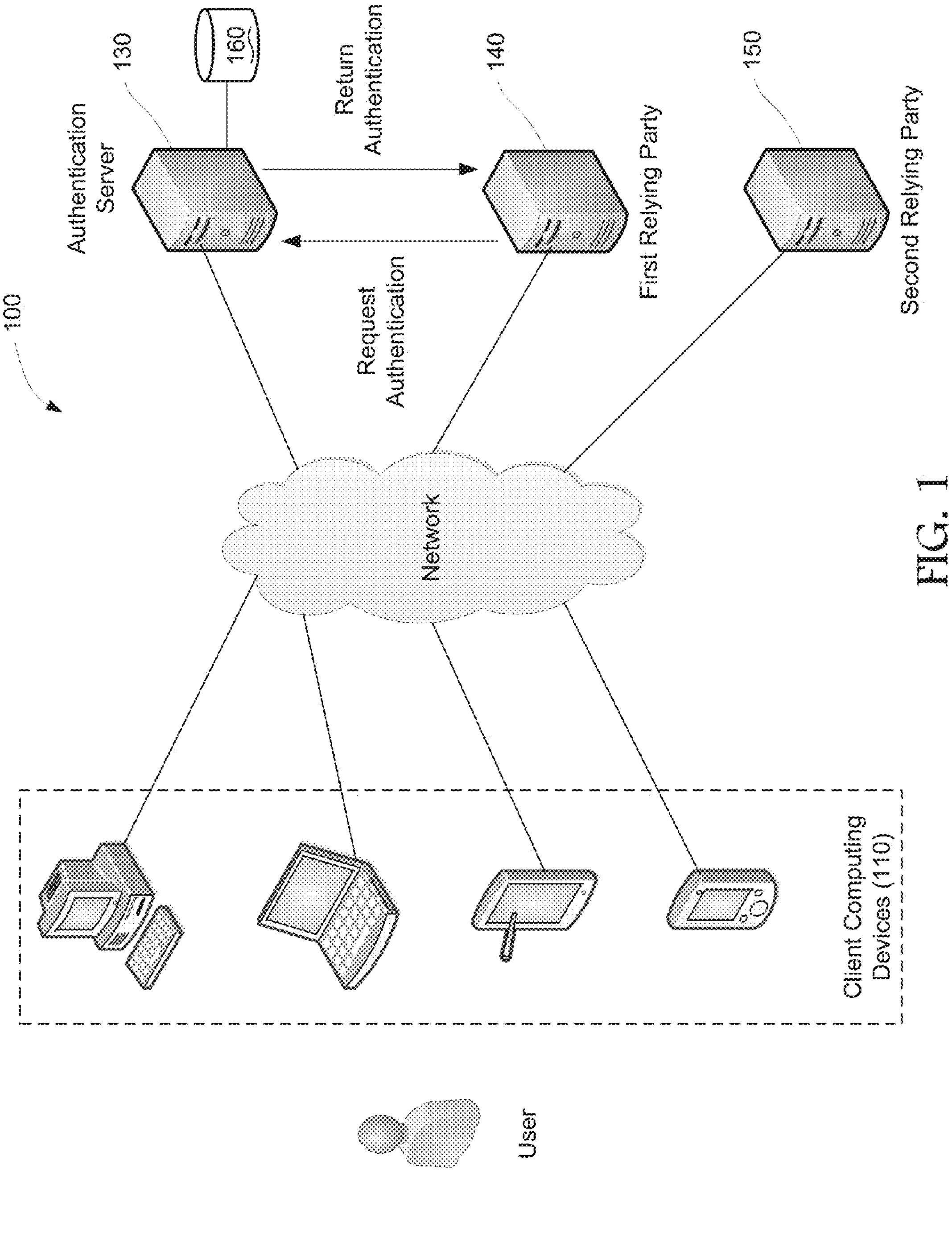
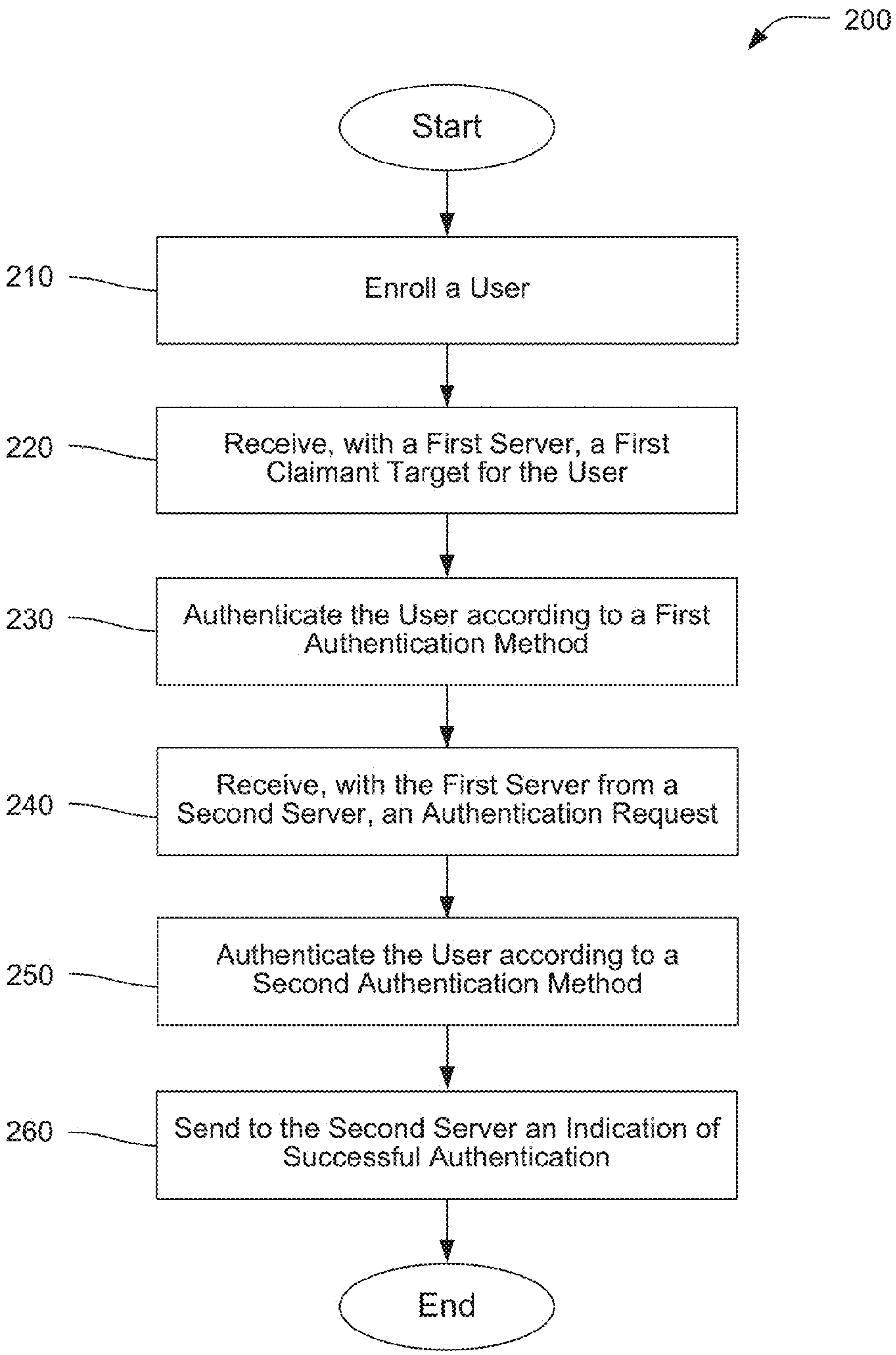

100
Authentication Server
130
160
Return Authentication
Request Authentication
140
First Relying Party
150
Second Relying Party
Network
Client Computing Devices (110)
User

FIG. 1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Receive, with a First Server, a First Claimant Target for the User
230
Authenticate the User according to a First Authentication Method
240
Receive, with the First Server from a Second Server, an Authentication Request
250
Authenticate the User according to a Second Authentication Method
260
Send to the Second Server an Indication of Successful Authentication
End

FIG. 2

METHODS OF AUTHENTICATING USERS TO A SITE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of authentication and more particularly to user authentication within federated computing systems.

2. Related Art

Passwords, one-time-passcodes (OTPs), image selection, biometrics and other methods are commonly used to authenticate users before providing access to sites or other services including online accounts, physical spaces and those provided person-to-person. The Internet and private networks provide users with access to multiple services offered by distinct service providers each requiring independent authentication of users. Typically, a user is required to provide a username/password pair to identify the account to the service provider. The requirements for username/password pairs vary among service providers. The condition has led to users having multiple distinct username/password pairs that must be remembered and kept secret by the user.

It is generally accepted that a username/password pair identifies the user in addition to identifying the account. The username/password pair may identify the user if the username/password pair is only known to the user and the authenticating system. In the presence of a compromised username/password pair, only the account is identified. Other users and particularly criminal users can abuse the account and services provided if they gain knowledge of the username/password. Additional methods of authentication have been created to prevent unauthorized access to accounts and services. These include biometrics and identification of devices to name a few.

Using combinations of the methods lead to additional methods. For instance, using voice and face biometrics can lead to fusion methods in which the independent results of voice and face recognition are processed to derive another measurement. There are many methods, modalities, etc. that can be used for authenticating users. The methods for authenticating a user are commonly based on one or more authentication factors, the most common being 1) something the user knows, 2) something the user has, 3) something the user does, and 4) something the user is. Other categories may exist.

A username/password pair is an example of "something the user knows." Another example of "something the user knows" includes answering a question such as: what was the last charge on your credit card? If a username/password pair is used exclusively to authenticate a user, it is described as a single-factor authentication. Likewise, if a fingerprint is used exclusively to authenticate a user, it is described as a single-factor authentication.

If more than one factor is used to authenticate a user, the authentication is described as multifactor. For instance, username/pas sword and an OTP sent to a user's cellular phone that must be transcribed and sent to the authenticating system are described as a multifactor authentication. In this example, the multifactor authentication includes "something the user knows" (username/password) and "something the user has" (a cellular phone). It is thought to be more difficult for criminals to compromise accounts/sites that require more than one factor. Therefore, the factors and the number of factors applied to an authentication indicate the strength of authentication. It follows that users and service providers require/desire different authentication methods to better secure some servers, services and sites. Simultaneously, users and service providers require/desire more convenient authentication methods for other servers, services and sites.

Users that require/desire access to multiple services offered by multiple vendors often must know multiple credentials and be familiar with multiple authentication methods. For instance, a tablet may require a fingerprint scan, while the phone may require a passcode and a username/password, while a Personal Computer (PC) connected to the Internet may require a username/pas sword and an OTP for some collection of services. To simplify the authentication tasks in multi-service environments, services can trust the authentication performed by another service and avoid inconveniencing the user with additional authentication. For instance, logging into a corporate network often employs a username/password provided to a trusted authentication server. The user does not need knowledge of the particular trusted server providing the authentication. Once authenticated, the user may be authorized to use services provided by other servers that trust the authentication. When the user attempts to access a service available on the exemplary corporate network, the service contacts the authenticating server and verifies the user authentication. If the user has been authenticated, the user may be permitted to access the service. Otherwise, the user may be authenticated by the service or a trusted authentication server.

Networked environments comprising multiple servers that trust the authentication provided by other servers are described as federated. There exist a number of standards, protocols and implementations of federated authentication systems including: the Microsoft Security Token Service, OpenID Connect, Shiboleth, etc. Federated authentication systems operate within a trust framework comprising one or more authentication servers that provide results relied upon by another party. The authentication servers are known as Identity Providers (IPs). The consumers of the authentication results are known as Relying Parties (RPs). A server, service or site can be both an IP and an RP.

Federated authentication systems can simplify the user environment by providing the user with the choice of using a single authentication service. Users can select a single authentication server, authenticate once and have access to multiple services. This benefit is commonly referred to as Single Sign-on (SSO). Federated authentication systems provide varying methods of authentication that can often be selected by the user. For instance, a user may choose to use multifactor authentication including a username/password and OTP. Such a choice reflects a user's willingness to endure additional inconvenience (they must have their phone) in exchange for greater perceived security (use of additional factors). Once authenticated, however, the user gains access to services offered by servers in the federation. The user may be prompted to identify themselves to other servers participating in the federation. Therefore authentication servers provide a federated identity to users.

It should be appreciated that while federated authentication servers offer varying authentication methods, the user must select one. For instance, if a user chooses username/password for their authentication method to their federated authentication server, the authentication is valid for all servers, services and sites participating in the federation. In other words, the authentication applies equally to the user's bank account and the user's social media account. Because of this, savvy users may opt to authenticate with strong methods or authenticate separately to high-value accounts; both inconvenient to the user.

SUMMARY

The present invention provides methods for authenticating a user to multiple servers within a federated computing system. An exemplary method that can be performed, for example, by a first server comprises receiving, with the first server, a first claimant target for the user and, in response, authenticating the user to the first server according to a first authentication method. After authenticating the user, the method further comprises receiving with the first server from a second server an authentication request including a site identifier and a second claimant target, and then sending to the second server an indication of successful authentication. Some embodiments further comprise enrolling the user before receiving the first claimant target. Enrolling the user can comprise creating a record for the user, where the record stores a user ID for the user and further stores an association between an identity of the first authentication method and of the first server. In some embodiments, the step of enrolling the user can permit the user to select from between multiple authentication method choices, and therefore the method can also comprise receiving a user selection of the first authentication method.

In various embodiments, the step of authenticating the user to the first server includes determining the first authentication method so that an appropriate authentication method will be used. Determining the first authentication method, in some embodiments, can include selecting the first authentication method from a plurality of authentication methods identified in a record for the user, such as where the user is offered a choice of possible authentication methods. In other embodiments the first server is in communication with a client computing device employed by the user, and in these embodiments the step of determining the first authentication method can includes identifying the client computing device in order to employ an authentication method that is supported by the client computing device.

If the user seeks to authenticate with a second server after authenticating with the first server, the exemplary method provides alternatives that depend on whether the second server can be accessed using an authentication method that the user has already performed during the session. For example, where the user has authenticated previously during the session with the first authentication method but the first authentication method is not an acceptable option for the second server, the exemplary method further comprises using the second claimant target to locate a record for the user, to select a second authentication method stored in association with the site identifier in the record, and to authenticate the user according to the second authentication method. However, in a situation where the user has authenticated previously during the session using the first authentication method and the second server can accept the first authentication method, the exemplary method further comprises using the second claimant target to locate a record for the user, determining that the first authentication method is stored in association with the site identifier in the record, and determining that the user had previously been authenticated according to the first authentication method, which may be indicated by a flag, for example. Upon the determination that an appropriate authentication method has been completed, either presently for the desired server or previously during the session for another server, an indication of successful authentication is sent to the second server.

The present invention also provides a federated computing system. An exemplary federated computing system comprises a database, an authentication server, and at least one relying party server. The database is stored on a non-transitory storage medium, and includes a record for a user. The authentication server is configured to receive a first claimant target for the user, authenticate the user according to a first authentication method, and after authenticating the user, to receive an authentication request including a site identifier and a second claimant target. Each relying party server is in communication with the authentication server across a network, and each is configured to send an authentication request, including its site identifier and a claimant target, to the authentication server and to receive an indication of authentication back from the authentication server.

In various embodiments of the federated computing system, the authentication server is further configured to use the second claimant target to locate a record for the user in the database, to select a second authentication method stored in association with the site identifier in the record, and to authenticate the user according to the second authentication method. In other embodiments, the authentication server is further configured to authenticate the user by determining the first authentication method, where determining the first authentication method includes using the second claimant target to locate the record for the user in the database, determining that the first authentication method is stored in association with the site identifier in the record, and determining that the user had previously been authenticated according to the first authentication method. In still other embodiments, the authentication server is further configured to determine the first authentication method, before authenticating the user according to the first authentication method, by selecting the first authentication method from a plurality of authentication methods identified in a record for the user. In still further embodiments, the first server is in communication with a client computing device employed by the user, and in these embodiments the step of determining the first authentication method can include identifying the client computing device so that an authentication method appropriate to the client computing device can be employed.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic representation of a federated computing system according to an exemplary embodiment of the present invention.

FIG. **2** is a flowchart representation of a method for user authentication within a federated computing system, according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides methods for simplifying user authentications within federated computing systems, and to computing systems that implement these methods. In a given session, a user can be authenticated multiple times by different authentication methods to access services from different servers of the federated computing system, however, once the user has been authenticated during the session by a particular authentication method, the user need not repeat that method in order to access further servers that permit authorization through that authentication method.

Systems of the present invention comprise a plurality of servers, one authentication server and a number of relying party servers configured to communicate with the authentication server across a network. The authentication server maintains authentication records for users of the federated system, where each record stores various associations that indicate which authentication methods are used to authenticate a given user to the various relying party servers. Optionally, users can select which authentication method may be used for accessing the various relying party servers. Optionally, for a particular relying party server, the appropriate authentication method will depend on the type of client computing device the user employs to seek access. When a user seeks access to a particular relying party server for the first time during a session, the relying party server sends identifiers for both the user and the relying party server to the authentication server, and the authentication server then determines whether the user has already been authenticated to another federated server according to the authentication method required by the current relying party server. If so, the authentication server indicates to the current relying party server that the user is authenticated, else the authentication server invokes the necessary authentication method. Upon completion, the authentication server indicates to the current relying party server that the user is authenticated.

FIG. **1** schematically illustrates the components of a federated computing system **100**. The federated computing system **100** comprises a plurality of client computing devices **110** configured to communicate across a network **120**, such as the Internet or a cellular phone network, with an authentication server **130** and with one or more relying party servers. In the example of FIG. **1**, two relying party servers are illustrated, a first relying party **140** and a second relying party server **150**. A user is able to access various relying party servers **140**, **150** using the client computing devices **110** in order to obtain services therefrom. As shown in FIG. **1**, each of the relying party servers **140**, **150** is configured to communicate across the network **120**, or another network (not shown), with the authentication server **130** in order to pass authentication requests and results therebetween. The authentication server **130** and the relying party servers **140**, **150** are collectively referred to herein as the federated servers.

Exemplary client computing devices **110** include laptop computers, desktop computers, tablet computing systems, and smartphones. Client computing devices **110** are configured with one or more web browsers that enable the user to view and interact with content provided by the federated servers. A session, as used herein, refers to a limited period of connectivity between a client computing device **110** and one or more federated servers. A session is initiated when a user is first authenticated to a federated server, as discussed below with reference to FIG. **2**, and can continue for as long as the user remains logged into at least one federated server. A session ends when either the user logs off from all federated servers or a threshold period of time is exceeded without activity.

The authentication server **130** is configured to manage records for multiple users, where a record for a given user can store associations between the user's federated identity, one or more claimant targets, one or more authentication methods, one or more client computing devices, and one or more site identifiers for various relying party servers such as relying party servers **140**, **150**. Such records can be stored in a database **160** comprising a non-transitory storage medium, like magnetic or optical storage, in communication with the authentication server **130**.

An exemplary method **200** of the invention is described with reference to FIG. **2**. The method **200** allows a user to authenticate to the authentication server **130**, for example, using a first authentication method, then later authenticate to a relying party server **140** or **150** either without having to repeat the first authentication, or in the alternative by being authenticated according to a second authentication method. Each time a particular authentication method has been successfully completed during a session, the user does not have to repeat that authentication method when approaching another relying party server **140**, **150** of the federated computing system **100**, where the other relying party server **140**, **150** can be accessed after successfully completing that authentication method. The method **200** can optionally provide customization to the user to select authentication methods for different relying party servers **140**, **150** and to employ different client computing devices **110**.

In a step **210** of the method **200** a user is enrolled, for example, by authentication server **130** or by a dedicated enrollment server (not shown) in communication with the database **160** shared with the authentication server **130**. In the enrollment process, an enrollee user is associated with a unique user ID and a record that including the user ID is created for the user and stored in the database **160**. The user ID serves as a federated identity for the user across the servers of the federated computing system **100**. The user ID can comprise, for example, a username, a URL, a code stored by a physical card, etc. Information about the user optionally can be collected during enrollment, such as the user's name, phone numbers, addresses, and the like, and stored in the record of the database **160**.

During the enrollment process of step **210**, the user can be prompted to set up at least one authentication method that can be subsequently used to authenticate the user to the authentication server **130**. The user optionally can also set up other authentication methods that may be required to access one or more relying party servers **140**, **150**, or these additional authentication methods can be addressed at a later time. In some embodiments the user enrolls in step **210** by employing an application running on a client computing device **110** that communicates with the authentication or enrollment server. In other embodiments, the user employs a browser running on a client computing device **110** to access a website served by the authentication or enrollment server to enroll in step **210**. The same application or website can be employed by the user to return at a later time to make changes to the record in the database **160**. Such changes can include associating authentication methods to relying party servers **140**, **150** that were not previously addressed, changing which authentication methods are associated to particular relying party servers **140**, **150**, and specifying rules such as that the same authentication method cannot be repeated for the same federated server in successive sessions.

Exemplary authentication methods can require the use of an OTP, the user's biometrics, username/password pairs, and so forth. Exemplary authentication methods can be single factor or multi-factor, and can be single channel or multichannel. Examples of multi-factor authentication methods are illustrated by U.S. Pat. No. 8,006,291 issued on Aug. 23, 2011 and U.S. Pat. No. 8,516,562 issued on Aug. 20, 2013, both entitled "Multi-Channel Multi-Factor Authentication," and by U.S. Pat. No. 8,536,976 issued on Sep. 17, 2013 and entitled "Single-Channel Multi-Factor Authentication," all three of which are incorporated by reference herein.

The possible authentication methods that can be used in conjunction with the present invention span a wide range of strengths. Authentication methods can be categorized by their strength-of-authentication, for example, by a numerical score or a relative ranking such as "low," "medium," or "high." In some embodiments, access to a given federated server, or to a service provided by the federated server, will require an authentication method that meets a minimum strength-of-authentication level. In these embodiments, when associating an authentication method to a federated server during the enrollment step **210**, an authentication method that meets the minimum strength-of-authentication may be automatically selected for the user, such as where only one authentication method is available with the required strength. In other instances, the user can be given an opportunity to select from a number of authentication methods that meet the minimum requirements. In these embodiments, the user can be presented with the authentication methods and their associated strengths, and the authentication or enrollment server will receive the user selection and store the selection in the dedicated record for the user.

Further user customizations that can be selected, in some embodiments, include the ability to select more than one authentication method to associate with a federated server. Where several authentication methods are associated with a given federated server, the user can further select to have a different authentication method used for each new session, by rotation through an order or by random selection, for example. In some embodiments, the user can opt to be given the choice, at the time authentication is requested, as to which authentication method, of several with sufficient strength, to employ for that session.

For each authentication method selected, additional steps may be required. Setting up an authentication method that employs an OTP can include, for example, receiving from the user a cellphone number that will be used to transmit OTPs to the user during subsequent authentications. The cellphone number is then stored in association with an identifier for the OTP authentication method in the record for the user. Similarly, an authentication method that employs a username/pas sword pair would have the user establish a unique username/pas sword combination and store the same in the record for the user in association with an identifier for that authentication method. In these embodiments, the username may be the same or different than the user ID. In both examples, a claimant target is established for the authentication method. As used herein, a claimant target comprises information that serves to indicate the identity sought to be authenticated and is used by the authentication server **130** to locate the appropriate record for the user from the database **160** and can take many forms including the user ID, a username, a biometric such as an image of the user's face, a fingerprint scan, and the like.

Setting up an authentication method that employs a biometric can include, for example, having the user provide a biometric response that is stored as a biometric template in the record for the user in association with an identifier for the authentication method. During authentication, a biometric response from the person seeking to be authenticated is compared to the biometric template to determine whether a sufficient match exists. Again, a claimant target is established for the authentication method and stored in the record for the user in association with the authentication method.

As noted above, one or more authentication methods can be established for one or more relying party servers **140**, **150**. When this data collection is performed as part of step **210**, an association can be stored in the record for the user that associates the relying party server **140**, **150** to an identifier for any authentication methods selected for that relying party server **140**, **150**. Establishing an authentication method for a particular relying party server **140**, **150** can comprise, in some instances, allowing the user to select the authentication method from a list of suitable alternatives, or can comprise assigning an authentication method that is universally employed for the given relying party server **140**, **150**. Establishing the authentication method for a given relying party server **140**, **150** can also comprise determining a client computing device **110** to be used during a subsequent authentication. Thus, enrollment in step **210** can also include storing in the record an association between a relying party server **140**, **150**, a particular client computing device **110**, and an authentication method such that during a subsequent authentication

the proper authentication method for the given relying party server **140**, **150** and the correct client computing device **110** can be employed.

It will be appreciated that step **210** is an optional step in as much as enrollment can be performed by a third party, in some embodiments. In these embodiments, methods of authenticating users assume the pre-existence of a record for the user in the database **160**, as described above. These embodiments can begin, instead, at step **220** which is directed to receiving a first claimant target by the authentication server **130**. Embodiments that begin with enrollment in step **210** continue with step **220**. In step **220** the user can submit a claimant target from one of the client computing devices **110** over a communication channel through the network **120** to the authentication server **130**. For instance, the user can access a login webpage using a web browser running on the client computing device **110**, where the webpage prompts the user to provide a claimant target. In this way, the authentication server **130** receives the first claimant target from the client computing device **110**.

In a step **230** the authentication server **130** authenticates the user according to a first authentication method. The authentication server **130** can perform this step by searching the database **160** for the record for the user, using the claimant target to search the database **160** and locate the record. Having located the appropriate record, the authentication server **130** can authenticate the user according to the authentication method since the record provides the information needed to determine authenticity under the first authentication method, such as a password that matches the username, or a biometric template. In some embodiments, the authentication server **130** first locates the appropriate record, then determines the authentication method to be used. For example, the record may associate the authentication server **130** with identifiers for a plurality of authentication methods, and the authentication server **130** selects one of the plurality to use to authenticate the user for the session. The authentication server **130** can select randomly from the plurality, or select according to a set order, or select according to an order specified by the user during the enrollment step **210**. In still further embodiments, the authentication step **230** includes identifying a client computing device **110**, and then selecting the authentication method associated in the record for the user with the identified client computing device **110**. The identity of the client computing device **110** can be determined, for example, based on the communication channel or an IP address of the client computing device **110**, in various embodiments.

Once the appropriate authentication method has been selected in step **230**, the authentication server **130** invokes the method. Invoking the authentication method will depend on the nature of the authentication method. For example, if the authentication method employs an OTP, invoking the authentication method can comprise determining a phone number from the record for the user, generating the OTP, sending the generated OTP to the determined phone number over a first channel, and receiving the OTP back over a second channel within a time threshold. Invoking the authentication method can likewise comprise sending a prompt to a client computing device **110** and receiving a response therefrom.

Once the user is authenticated according to the first authentication method, an indicator such as a flag can be set in the record to indicate that the user has been successfully authenticated according to that authentication method. Additionally, a session is established by the authentication server **130** and assigned a session identifier. Information pertaining to a given session can be stored in the record for the user, or a separate record, in various embodiments, and can include a time stamp to indicate when the session began. As discussed further below, once the user is authenticated according to the first authentication method for the authentication server **130**, the user need not repeat the same authentication method in order to access a relying party server **140**, **150** that requires the first authentication method, but may have to perform a different authentication method. All such indicators for successful authentications are cleared at the end of the session. Optionally, the user can specify authentication always be performed for a site even if previously authenticated in a session.

In a step **240**, that follows step **230**, the authentication server **130** receives from a relying party server **140**, **150** an authentication request. The authentication request can be triggered by the user attempting to access services from the relying party server **140**, **150** using a client computing device **110** which can be the same or different than the client computing device **110** used in preceding steps. The relying party server **140**, **150** can receive a claimant target, such as those discussed above, from a client computing device **110** by prompting the user, for example. Each relying party server **140**, **150** has a unique site identifier, and when a relying party server **140**, **150** sends an authentication request, the authentication request includes both the site identifier and the second claimant target. The authentication server **130** receives such an authentication request in step **240**.

In step **240** the authentication server **130** also locates the record for the user, as the record includes the second claimant target, which optionally may be the same as the first claimant target. From the record in database **160**, the authentication server **130** determines whether the relying party server **140**, **150** identified by the authentication request is associated with an authentication method, and if so, determines whether the user has already been authenticated to another federated server using that authentication method. If so, the method **200** advances to a step **260** in which the authentication server **130** can send to the relying party server **140**, **150** an indication of successful authentication and the user does not have to repeat the steps of the authentication method. In still further embodiments, the relying party server **140**, **150** identified by the authentication request is associated with a minimum strength-of-authentication level. If the user had previously, during the session, been authenticated by any authentication method meeting the minimum strength-of-authentication level then the authentication server **130** can send to the relying party server **140**, **150** an indication of successful authentication.

If an authentication method is associated with the relying party server **140**, **150**, but the user has not already been authenticated by that authentication method during the session, then in a step **250** the authentication method required by the record for the user is invoked by the authentication server **130**. Upon successful authentication with this second authentication method, an indicator can be set in the record for the user so that the second authentication method need not be repeated subsequently during the session. Again, in step **260** the authentication server **130** can send to the relying party server **140**, **150** an indication of successful authentication.

If an authentication method is not associated with the relying party server **140**, **150** that the user seeks to access, in some embodiments the authentication server **130** automatically assigns an appropriate authentication method for the user to access the relying party server **140**, **150**, stores an indication of that authentication method in the record for the user in association with an indication of the identity of the relying party server **140**, **150**, and then invokes that authentication method. In other instances the user is prompted to select the authentication method from a list of acceptable methods, where the authentication server **130** then receives the selection, stores an association of the selection to the relying party server **140**, **150** in the record for the user, and invokes the authentication method to authenticate the user. In still further embodiments, the user can also specify that the association should not be stored in the record so that in a future session, should the user seek to access the same relying party server **140**, **150**, the user would have to again select an authentication method from the list.

In still further instances, the user can seek to access a relying party server **140**, **150** for which no authentication method has been established for the user. In these instances the authentication server **130** can receive, in step **240**, an authentication request specifying the site identifier and the second claimant target, and can then locate the record for the user, but would not find an authentication method for both the user and the relying party server **140**, **150**. The authentication server **130** can send the relying party server **140**, **150** an indication that authentication failed, in these situations. The user can be required to return to enrollment in step **210**, in some embodiments.

In still other embodiments of the method **200**, the user first seeks authentication from a relying party server **140**, **150**. In these embodiments, the relying party server **140**, **150** sends an authentication request comprising a site identifier and the claimant target to the authentication server **130**. In the step **220** the authentication server **130** receives this first claimant target. Then, in step **230**, the authentication server **130** locates the record for the user using the first claimant target to search the database, determines the appropriate authentication method for the relying party server **140**, **150** and then invokes that authentication method to authenticate the user. The authentication server **130** also opens a session and assigns a session identifier. Method **200** can continue with the user seeking to authenticate with another relying party server **140**, **150**, and in a step **240** the authentication server **130** receives from the other relying party server **140**, **150** another authentication request including the site identifier of the other relying party server **140**, **150** and second claimant target from the user. The second authentication can progress as described above in step **250**, resulting in the authentication server **130** sending to the other relying party server **140**, **150** an indication of successful authentication in step **260**.

While the session remains open, the user can continue to use different client computing devices **110** to access different federated servers, and the authentication server **130** will loop through step **240**-**260**. The method **200** ends when the session ends, either by the user logging off of each federated server that had been accessed during the session, else by timing out. The user can time out by not interacting with any federated server for more than a threshold period of time, such as 30 minutes. The authentication server **130** can query other federated servers periodically to determine whether the user has been active or not. Even if a user has been active, in some embodiments, the user may still time out by exceeding a maximum session duration, such as 8 hours.

In the foregoing specification, the invention is described with reference to specific embodiments thereof, but those skilled in the art will recognize that the invention is not limited thereto. Various features and aspects of the above-described invention may be used individually or jointly. Further, the invention can be utilized in any number of environments and applications beyond those described herein without departing from the broader spirit and scope of the specification. The specification and drawings are, accordingly, to be regarded as illustrative rather than restrictive. It will be recognized that the terms “comprising,” “including,” and “having,” as used herein, are specifically intended to be read as open-ended terms of art.

What is claimed is:

1. A method for authenticating within a single sign-on federated authentication system, the method comprising:

enrolling a user, including creating a record for the user, the record storing a user ID for the user and storing an association between a site identifier for a first server and a first authentication method, and storing a further association between a site identifier of a second server and each of a second authentication method and a third authentication method;

after enrolling the user, receiving, with the first server, a first claimant target for the user;

authenticating the user to the first server according to the first authentication method;

after authenticating the user to the first server, receiving with the first server from a second server an authentication request including the second site identifier and a second claimant target, wherein the first and second claimant targets each consist of one of the user ID, a username, or a biometric;

again authenticating the user according to a second authentication method including using the second claimant target to locate the record for the user, then

selecting the second authentication method from between the second and third a plurality of authentication methods associated with the second site identifier in the record for the user, then

authenticating the user according to the selected second authentication method including receiving a response from the user; and

sending to the second server an indication of successful authentication.

2. The method of claim **1** wherein enrolling the user comprises

receiving a user selection of the first authentication method.

3. The method of claim **1** wherein authenticating the user to the first server includes determining the first authentication method.

4. The method of claim **3** wherein determining the first authentication method includes selecting the first authentication method from a plurality of authentication methods identified in the record for the user.

5. The method of claim **3** wherein the first server is in communication with a client computing device employed by the user and wherein determining the first authentication method includes identifying the client computing device.

6. A system for authenticating within a single sign-on federated authentication system, the system comprising:

an enrollment server configured to enroll a user, wherein enrolling the user includes creating a record for the user, and storing in the record a user ID for the user, and storing in the record an association between a site identifier for a first server and a first authentication method, and storing in the record a further association between a site identifier of a second server and each of a second authentication method and a third authentication method;

a database, stored on a non-transitory storage medium, the database including the record for the user;

an authentication server configured to:

after enrolling the user, receive a first claimant target for the user,

authenticate the user according to the first authentication method, after authenticating the user to the authentication server, receive an authentication request including the second site identifier and a second claimant target, wherein the first and second claimant targets each consist of one of the user ID, a username, or a biometric,

authenticate the user again according to a second authentication method

including using the second claimant target to locate the record for the user in the database, then selecting the second authentication method from between the second and third a plurality of authentication methods associated with the second site identifier in the record, then authenticating the user according to the selected second authentication method, including receiving a response from the user; and a relying party server in communication with the authentication server across a network, the relying party server configured to send the authentication request to the authentication server and to receive an indication of authentication from the authentication server.

7. The system of claim **6** wherein the authentication server is further configured to determine the first authentication method by selecting the first authentication method from a plurality of authentication methods identified in the record for the user.

8. The system of claim **6** wherein the first server is in communication with a client computing device employed by the user and wherein determining the first authentication method includes identifying the client computing device.

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